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Original article

Tips and tricks in surgical management of maxillary sinus tumors

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ABSTRACT

Background: 3% of head and neck carcinomas are sinonasal malignancy.
Aim of study: Epidemiological evaluation of cancer maxilla in National Cancer Institute, Cairo University with emphasis on surgical strategy and intraoperative assessment of tumor extension that augment the oncologic, functional and esthetic results after resection of tumors of the maxilla.
Patients and methods: 30 patients diagnosed as malignant maxillary tumor in the surgical department, National Cancer Institute, Cairo University in the period from October 2012 to May 2016.
Results: In this study the most commonly recorded pathological diagnosis was squamous cell carcinoma 14 patients (46.7%). Most of the patients were presented with delayed presentation, in this study stage IVa was the most frequent stage (detected in 15 patients accounting for 50%).
Results: The overall survival of the studied cases was estimated using Kaplan-Meier survival estimate. It was of mean 22 months. The 2 year survival rate for the overall studied cases was 40%
Results: During the follow up period, local recurrence was recorded in 12 patients in this study (40%). Distant metastases were detected during follow up in two patients in this study (6.6%).
Conclusion: Fine intraoperative surgical maneuvers can obtain secured resection margin (with special attention to adenoid cystic carcinoma); avoid postoperative functional complications like trismus, nasal regurgitation of food, epiphora or double vision finally enhance esthetic results

1. Introduction

Malignancies of the nasal cavity and paranasal sinuses are rare, accounting for only 3% of head and neck carcinomas and about 0.5% of all malignant disease. The annual incidence rate is 0.5–1.0 per 100,000 population. These tumors are two times frequent observed in men than in women, mainly between 50 and 70 years old.[1] Of these malignancies, 80% originate from the maxillary sinus, and histologically, 60–90% of these cases have been shown to be squamous cell carcinoma.[2]

Although most sinonasal tumors necessitate aggressive surgical excision as part of a multimodality treatment plan, this is complicated by the proximity of the eye, brain, and carotid arteries to the sinonasal cavities, and the desire for an optimal cosmetic outcome. However, advanced techniques and experience in surgical tumor resection and reconstructive techniques has afforded many patients the opportunity for curative surgery than in previous decades.[3]

Overall poor prognosis of sinonasal malignancy, with 5-year survival rates traditionally ranging from 30% to 40% which may be due to vague presenting symptomatology eg. persistent nasal congestion, sinusitis, and recurrent epistaxis which are synonymous with benign inflammatory sinus disease. Subsequently, there is frequently a delay from 6 to 8 months from the onset of symptoms which results in a relatively advanced stage of disease at the time of diagnosis.[4]

Except for T1 mucosal carcinomas, the accepted method of treatment is a combination of surgery and radiation therapy. The incidence of lymph node metastases is generally low (approximately 20% of all cases). Thus, routine radical neck dissection or elective neck irradiation is recommended only for patients presenting with positive nodes.[5]

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As the maxillary sinus cancer progresses to the advanced stage, it invades the surrounding structures. Superiorly, it may invade the orbital fossa, anteriorly the skin, posteriorly the pterygopalatine fossa, and if it proceeds further through the posterior wall it may even invade the infratemporal fossa.[6]

2. Patients and methods

This study was conducted on 30 patients with malignant maxillary tumor who were admitted in the surgical department, National Cancer Institute, Cairo University in the period from October 2012 to May 2016.

Patients with intracranial extension or patients with distant metastasis are excluded.

2.1. Pre-operative assessment for all patients was done in this following protocol

1. Complete head and neck examination was performed, including
   - Assessment of overall facial symmetry.
   - Intraoral inspection of the hard palate, gingiva, and anterior maxillary wall.
   - Intranasal examination was performed, using rigid endoscope for optimal visualization of the nasalcavity and the nasopharynx.
   - Neck examination for evaluation of palpable lymph node. Mandibular movement was assessed for trismus.
   - Ophthalmological examination had been performed with attention to the range of extraocular muscle motion, visual acuity and signs of globe displacement.
   - Cranial nerves were tested with particular attention to nerves I through VI.
2. Computed tomography of the nose and paranasal sinuses in both coronal and axial views was the basic radiological tool used for all cases of this study (Fig. 1).
3. Complementary magnetic resonance imaging was done to precisely delineate involvement of the skull base, the orbits, the intracranial compartment, and potential perineural spread of tumor which may influence treatment options (Fig. 2).
4. Histopathological examination: Representative biopsy was taken through endoscopic guided procedure for large maxillary or intranasal masses in 13 cases. Also biopsy was taken under general anesthesia through Caldwell-Luc approach in 12 cases. For fungating tumors a punch biopsy was used to obtain a biopsy from hard palate in 5 cases.

According to clinical, radiological and pathological information obtained patients who were proved to have malignant maxillary sinus tumors underwent staging according to TNM classification and staging system according to American Joint Committee of Cancer 2006 and according to this a plane for appropriate surgical modality was designed.

Figure 2. MRI with a patient with maxillary mas showing LT perineural spread via V2 – foramen rotandum intracranially.

Figure 3. Marking for RT Weber Fergusson incision.

2.2. Surgical technique

Surgical approaches were selected according to the extent of the tumor.

Weber-Fergusson incision was done in 28 patients (93.3%) and transoral vestibular approach was performed in 2 patients (6.6%) (Fig. 3).

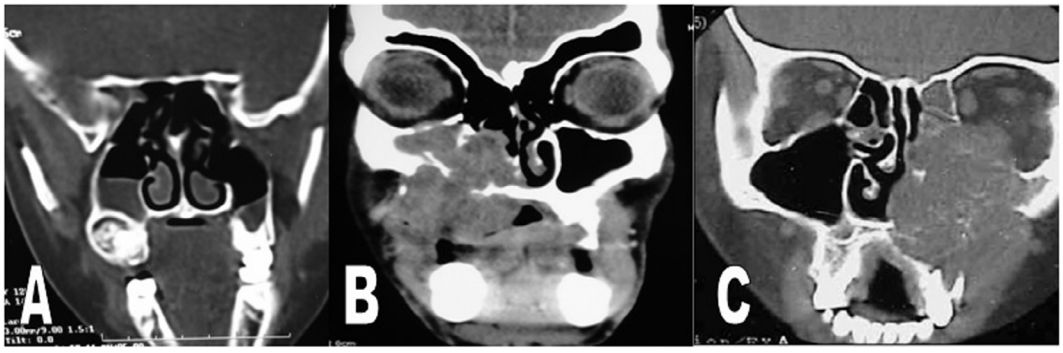

Figure 1. Pre-operative CT study of different patient with cancer maxilla. A = RT inferior maxillary mass with alveolar process invasion. B = RT maxillary mass with palate invasion and inferior orbital wall invasoin. C = LT maxillary mass with periorbita invasion, inferior rectus invasion.

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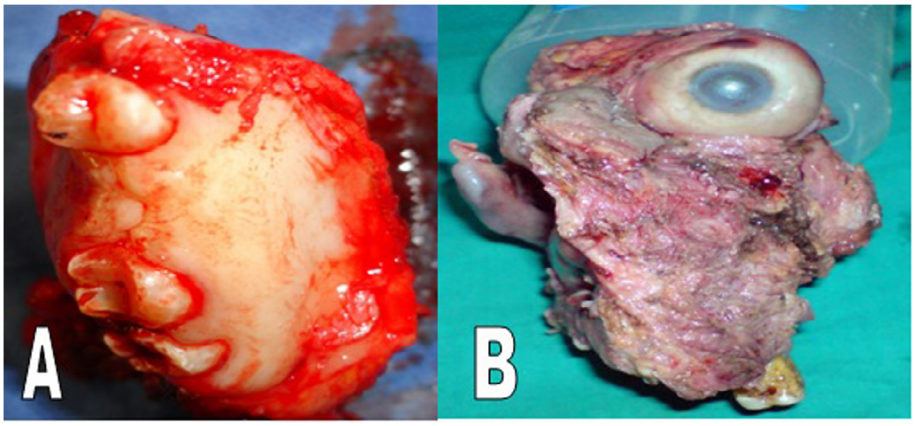

Figure 4. Maxillectomy specimen. A = inferior maxillectomy. B = radical maxillectomy with excentration.

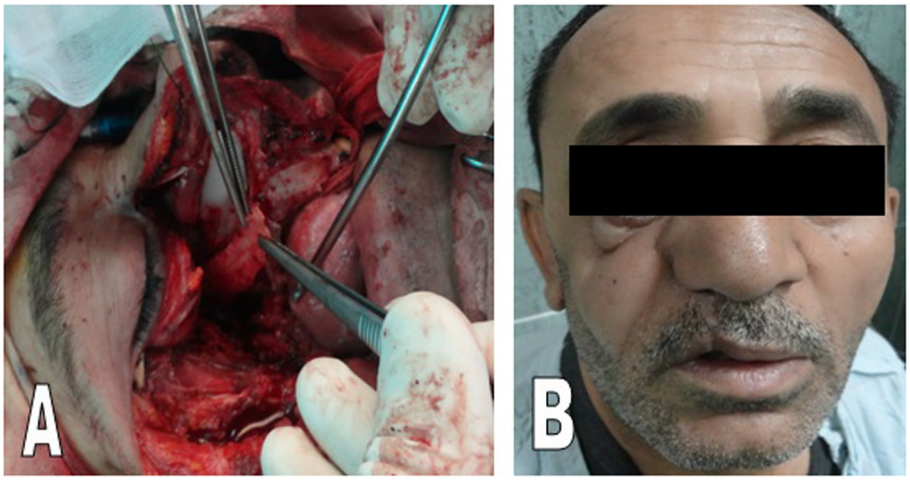

Figure 5. A = intraoperative reconstruction of RT inferior orbital floor by nasoseptal flap. B = 2 month postoperative view of the patient with inferior orbital floor repair with accepted globe position.

Total maxillectomy through Weber-Fergusson incision was performed in 9 cases, 6 cases of them had orbital floor resection.

If a larger area around the mass was removed, including the pterygoid muscle and the pterygoid plate when the tumor breaches the posterior wall of the maxilla, the procedure was termed radical maxillectomy which was performed in 19 cases

Inferior partial maxillectomy was done in two cases when the tumor was confined to the hard palate without adjacent structure invasion (Fig. 4).

Radical maxillectomy with orbital exenteration was performed in 2 cases when there was tumor invasion of orbital periostium and periorbita. The orbital cavity was filled with a temporalis muscle flap. (Fig. 4)

During these surgical procedures; we apply multiple strategic surgical maneuvers to detect extent of the tumor, to allow safe oncologic resection and in the same time to maximize functional out come.

1. Two exploratory steps,
   - First one is exploration of the orbital floor by dissecting the periostium of the orbit to detect tumor invasion to the periostium and the periorbita if there is radiological suspicion of orbital invasion, if there is tumor extension orbital exenteration is done.
   - Second one is exploration of the lateral wall of the maxilla at the junction between the body and frontal process of the zygoma to decide if the zygoma is included in the resection or left for cosmoses.
2. Detecting the extension through the anterior wall of the antrum by dealing with the facial flap which was elevated in a subcutaneous plane, leaving the facial musculature in the specimen.
3. Detecting the extension through the posterior wall of the antrum to make a decision about excision of the pterygoid complex or not to achieve adequate margin.

Avoiding post-operative complication by primary interventions during the oncological surgery as follow:

Avoiding post-operative diplopia and double vision in cases of orbital floor resection by using rotation mucoperichondrial flap from the nasal septum then the rotated septum was fixed to the zygoma by Vicryl (3/0) for reconstruction of the floor and medial walls of the orbit Fig. 5.

Avoiding intraoperative excessive bleeding by ligation of the internal maxillary artery at the pterygomaxillary fissure before removal of the specimen

Avoiding post operative trismus by prophylactic coronoidectomy and resurfacing the raw area by split thickness skin graft to limit postoperative soft tissue fibrosis which enhance trismus and to facilitate also obturator fitting.

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Avoiding postoperative epiphora by dacrocystorhinostomy in all cases, The nasolacrimal duct was divided, and the lacrimal sac was opened and marsupialized. The interrupted lacrimal system was later restored during closure with the creation of a dacryocystorhinostomy to avoid postoperative epiphora.

Avoiding postoperative sinusitis which may mimic local recurrence by ethmoid and sphenoid sinus curettage

Avoiding postoperative nasal regurgitation of food and water and provide good quality of voices, hard palate defect with a palatal obturator to separate the oral cavity from the sinus and nasal cavities. Two distinct prostheses were used, temporary surgical obturator and final prosthesis. The temporary surgical obturator was fitted immediately after surgical resection and kept in situ for approximately 2–3 weeks after surgery. The obturator was fabricated preoperatively with dental impressions taken by the prosthodontist and then fitted intraoperatively according to the extent of the surgical resection. The final prosthesis fabricated by a maxillofacial prosthodontist was modified according to the shape and size of the maxillectomy cavity within the next 6–12 months.

Avoiding locoregional recurrence by obtaining Intraoperative frozen section before closure of the wound through biopsies taken from soft palate, ethmoidal mucosa, sphenoidal mucosa and soft tissue over the ptrygoid plate and sent for frozen section to ensure the safety margin, in case the frozen section was positive re-excision of additional safety margin up to drilling the base of the middle cranial fossa in cases of adenoid cystic carcinoma with perineural invasion.

2.3. Post-operative assessment for all patients was done in this following protocol

Clinical examination, computed tomography (CT) scans of the nose and paranasal sinuses in both coronal and axial views were done approximately every 6 months for 2 years after surgery and on a yearly basis thereafter. The overall follow-up ranged from 12 to 32 months (median, 18 months). All survivors were followed up for at least 1 year or till the end of the study.

3. Results

The mean age of the patients enrolled in this study at the time of surgery was 47 ± 0.8 years with a maximum of 65 years and a minimum of 27 years. The patients were 18 males (60%) and 12 females (40%). It is observed that smoking was the most frequent finding among males (13 out of 18 patients). This finding is not well observed in female (only 1 out of 12).

Total maxillectomy through Weber-Fergusson incision was performed in 9 cases, two third of them (6 cases) had orbital floor resection.

Radical maxillectomy which was performed in 19 cases. two cases of them associated with orbital exenteration.

Inferior partial maxillectomy was done in two cases when the tumor was confined to the hard palate without adjacent structure invasion.

Tumor characteristics are shown in Table 1.

Table 1
Different pathological characteristics of carcer maxilla biopies.

Pathology	Number	%
Squamous cell carcinoma	14	46.7
Adenoid cystic carcinoma	9	30
Adenocarcinoma	5	16.7
Rhabdomyosarcoma	1	3.3
Fibrosarcom	1	3.3
Total	30	100

Table 2
Radiological Findings of included nasal masses.

Radiological finding	Number	%
Intranasal extension	13	43.3
Ethmoidal sinus invasion	12	40
Anterior maxillary wall and check invasion	12	40
Pterygoid plate erosion	9	30
Superior alveolar invasions	8	26.7
Infratemporal fossa invasion	7	23.3
Orbital invasion	8	26.7
Orbital floor	6	20
Intraocular muscles	2	6.6
Intraocular fat	2	6.6
Skull base invasion	2	6.6
Sphenoid sinus invasion	1	3.3
Lymph node spread	1	3.3

In this study the most commonly recorded pathological diagnosis was squamous cell carcinoma (14 patients, 46.7%).

Regarding the radiological findings, it is shown in Table 2

Most of the patients were presented with delayed presentation which was reflected on the staging classification of the patients. In this study;

- Stage IVa was the most frequent stage (15 patients, 50%).
- Stage III was the 2nd most common stage (8 patients 26.7%)
- Stage II was the presentation of 7patients (23.3%)

No patients had postoperative epiphora, No patients had postoperative trismus and all patients had accepted mouth opening with inter incisor distance more than 3 cm. After reconstruction of the orbital floor by rotation septal flap enophtalmos was observed in 2 patients, limited downward movement in 3 patients. Eye lid position was accepted in all cases

Resection margins after intraoperative frozen section were positive in 8 patients (26.7%) and further resection (up to drilling of the skull base) was made until safe margin was reached (as detected by frozen sections) or reaching vital non resectable structure.

Postoperatively, the specimen was sent for final pathological examination. It was found that resection margin was positive for malignancy in 9 patients (30%). Positive resection margins were found more with adenoid cystic carcinoma and with advanced stages of disease especially if posterior invasion is marked.

During the follow up period, local recurrence was recorded in 12 patients out of the 30 patients included in the study (40%). The sites of the recurrence were as follows; 7 cases at infratemporal fossa and pterygopalatine fossa, 3 cases with perineural spread and extends to intracranial cavity through foramen ovale, 1 case on the skull base,1 case with recurrence at the orbital apex from the trigeminal nerve along the ophthalmic branch.

No cases with nodal recurrence were noticed in the current study. 4 cases were referred to the medical oncology department to start there chemotherapy, 2 patients die with the disease while the remaining 6 cases missed from follow up.

Distant metastases were detected during follow up in two patients in this study (6.6%). Both cases were diagnosed as adenoid cystic carcinoma and they develop hip and femur shaft metastasis. They received chemotherapy.

The overall survival of the studied cases was estimated using Kaplan-Meier survival estimate Fig. 1. It was of mean 22 months. The 2 year survival rate for the overall studied cases was 40%.

3.1. Statistical analysis

Statistics were done by computer using MedCalc® Version 9.2.0.1 A word processing, data base and statistics program.

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The tests used were:

- X mean, SD standard deviation: to measure the central tendency of data and the distribution of date around the mean.
- Student's *t*-test: for testing statistical significant difference between means of two samples
- X2 test (Chi square test) to test statistical relation between different variable or grades (qualitative data).

4. Discussion

Maxillectomy was first described in the early 19th century, but there is still some confusion regarding the terminology and still a lack of a standard nomenclature and some confusion exists between terms.[7] To clarify these discrepancies, a classification system was described by Shah et al.[8] which categorized maxillectomies into limited, subtotal, and total maxillectomies. The limited maxillectomy removes primarily one wall of the maxilla, either resection of the medial wall or the floor of the maxillary sinus while the subtotal maxillectomy removes at least two walls, including the palate. Total maxillectomy is a term reserved for procedures resecting the entire maxilla. And radical maxillectomy which entails excision of the pterygoid plate is performed along with the maxillectomy which provide sufficient safety margins and lower the local recurrence rate in the cases of advanced maxillary sinus cancers invading the infratemporal fossa.

In this study more than 75% of patients presents with stage III and IVa and this could be explained that as the cancer develops in the confined space of the maxillary sinus, it causes no early signs or symptoms therefore a substantial number of patients have advanced disease at the time of diagnosis as mentioned by many authors.[9–11]

The most commonly recorded pathological diagnosis in this study was squamous cell carcinoma (43.3%). Which is near to that published in the literature.[12]

The extent of maxillectomy is based on both the preoperative radiological findings and the intraoperative exploratory steps. If the tumor involves the hard palate without invasion of the maxillary sinus then inferior subtotal maxillectomy is done, but if the tumor invades the maxillary sinus, then total maxillectomy is performed. When the tumor breaches the posterior wall of the maxilla radical maxillectomy is performed.[13] Medial maxillectomy is appropriate for limited, low-grade tumors of the medial wall of the maxillary sinus, nasal cavity, and ethmoid sinus, such as inverted papilloma. The entire medial maxillary wall, lamina papyracea and ethmoid sinus are removed in this procedure.[13]

The choice of approach depends on the type of maxillectomy being performed. Limited maxillectomy for small lesions of the hard palate or floor of the maxillary sinus may occasionally be approached transorally without the need for any facial incisions. A midface degloving or Denker's approach offers better inferior maxillary exposure while also avoiding any external skin incisions. Medial maxillectomy requires a lateral rhinotomy incision with a Lynch extension for improved ethmoid exposure superiorly. Larger nasal cavity and maxillary lesions require a Weber-Ferguson incision. A combination subciliary and supraciliary extension of the Weber-Ferguson incision is indicated for total maxillectomy with orbital exenteration.[7]

Since the introduction of orbital preservation surgery more than 30 years ago, the indications and need for removal of orbital structures have diminished. The 2 main points of contention are the oncological safety of orbital preservation and the functional outcome in preserved eyes.[14]

Intraoperative decision regarding orbital exenteration was variable when there is radiological suspension of orbital invasion; In this study, we made a decision about exenteration if orbital periosteum cannot be dissected easily from orbital floor, Carrau et al.,[15] concluded that the orbit may be spared if the full thickness of the periorbita is not breached by tumor. McCary et al.,[16] Perry et al.,[17] and Chambers et al.[18] they concluded that periorbital invasion does not necessarily indicate a need for orbital exenteration. They found that preoperative radiation therapy followed by intraoperative frozen section and selected resection of the involved periorbita may save the eye without a compromised outcome; Richard et al.,[7] concluded that care must be taken to avoid attempting orbital preservation at the potential cost of decreased local disease control and survival. Their approach is to resect involved periorbita and preserve the orbital contents in cases where there is no invasion of orbital fat, orbital musculature, or involvement of the orbital apex. The invasion of any of these structures is an indication for orbital exenteration.

Because the pterygoid venous plexus and the IMA supplying the maxilla are located posterior to the maxilla, intraoperative bleeding control is difficult before the specimen is completely removed. In an attempt to reduce intraoperative bleeding we control the maxillary artery at the pterygomaxillary fissure before removal of the specimen and this goes with Dulguerov[19] who palpate the maxillary artery under the fat plane containing the pterygoid plexus and is always ligated just behind the coronoid process of the mandible, Also he recommends that when the osteotomy is performed at the root of the pterygoid plate, it is done slightly away from the skull base to avoid injury to the emissary vein.

We strongly recommend frozen section analysis of the margin as after pathological examination of the resected specimens, it was found that resection margin was positive in about 10 patients (30%) nearly half of them were adenoid cystic carcinoma which necessitate additional resection up to drilling the skull base in cases of perineural spread.

The principal objectives of reconstruction of defect after total maxillectomy are to provide support to the orbital contents to avoid displacement of the globe and visual alterations, to obliterate any communication between the mouth and the nose and the nasopharynx and anterior cranial base to prevent ascending infections, to reconstruct the palatal surface to enhance articulation and deglutition, to reconstruct the lacrimal apparatus and to provide enough tissue volume to achieve facial symmetry and a good esthetic result.[20]

In our patients we used obturator prosthesis, although the choice between obturator prosthesis and reconstruction with a flap to close the palatal defect after maxillectomy is still controversial. The major advantages of the obturator prosthesis are that it allows inspection of the resection site and that the retention of an obturator is better than a prosthesis constructed on a flap. The major advantages of flap obturation are that it allows immediate one-stage reconstruction with minimal postoperative supervision and avoids the discomfort associated with an obturator.[21]

The goals of reconstruction of the orbital floor are functional and esthetic. The orbital contents must be supported to avoid globe displacement and distorted vision when orbital contents sink into the cheek creating a dystopia, diplopia and essentially nonfunctional eye.[22] Many different types of implant materials for orbital floor reconstruction have been described. Autologous materials include bone from rib or iliac crest which must be sandwiched between a healthy flap (either rectus abdominis or temporalis), and septal or ear cartilage. Alloplastic materials include Medpore, titanium mesh, hydroxyapatite, and many other materials.[23] We used rotation septal flap for reconstruction of the orbital floor as it carries the following advantages; it is taken from the same surgical field, no extra cost, no possibility of rejection and it is relatively a simple manoeuvre. In this study enophtalmos was observed in 2 patients, limited downward movement in 3 patients. Eye lid position was accepted in all cases.

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In head and neck cancer patients, trismus may result from invasion of tumor into masticatory musculature, the ascending ramus of the mandible, or temporomandibular joint (TMJ). Soft tissue fibrosis of these same regions from irradiation or surgery is another significant etiology. Trismus occurs in up to 47% of head and neck cancer patients, with potential complications including dysphagia, impaired speech and oral hygiene, airway compromise, and difficulty with tumor surveillance. Trismus typically does not become clinically significant until approximately 4 months postirradiation.[24] So, We had a trend to detach the temporalis muscle insertion, perform coronoidectomy and divide the ptregoid muscles in patients underwent total or radical maxillectomy to avoid post operative trismus either secondary to post operative fibrosis of muscles of mastication or radiation fibrosis.

There are different modalities to treat acquired nasolacrimal duct obstruction either external dacryocystorhinostomy and endoscopic endonasal.[25] In anticipation of postoperative lacrimal duct obstruction we perform routine external dacryocystorhinostomy in our cases and we didn't face postoperative epiphora in our cases.

During the follow up period in this study, local recurrence was recorded in 12 patients out of the 30 patients (40%) and distant metastasis were observed in (6.6%) of the studied cases. It was found that higher local recurrence rate was associated with T4 (46.6%) and adenoid cystic carcinoma. Dulguerov et al.,[19] found that the local recurrences were noted in (41.3%) and distant metastasis in (8.1%) which is nearly similar to that of the current study. Yousem et al.,[26] found the local recurrence rate for adenoid cystic carcinoma was the highest in the sinonasal cavity (63%).

The mean survival duration for the included cases is 22 months. The survival rate for the overall studied cases was 40%. These results were in agreement with that obtained by Waldron et al.,[27] in a retrospective analysis of 110 cases with malignant paranasal tumors where they found the survival rate as (42%), Bhattacharyya[10] found that the survival rate was 35%; Kenichi et al.,[28] Dulguerov et al.,[19] and Marcus et al.,[29] found higher survival rate (72%). The wide variation in the survival rates within the reviewed literature and this series could be explained by the fact that survival for patients with maxillary sinus cancer was determined not only by TNM staging but also by the age of the patients, tumor pathology and grade and the selected treatment option. It was also noticed that some studies were done retrospectively over a long period (over than 10 years) which will affect the rates of survival.

5. Conclusion

Intraoperative decision-making about oncological principles to obtain safety margin and primary reconstructive maneuvers could decrease surgical morbidity and improve quality of life as it avoids postoperative trismus, nasal regurgitation of food, epiphora or double vision, and also enhance esthetic results.

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Conflict of interest

The authors declare no conflict of Interest.

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